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**MATERIALS PROCESS DESIGN  
BRANCH**

**Work Unit Directive (WUD) 54**



**Steve R. LeClair, et al.**

**Materials Process Design Branch (AFRL/MLMR)  
Manufacturing Technology Division  
Materials and Manufacturing Directorate  
Air Force Research Laboratory, Air Force Materiel Command  
Wright-Patterson Air Force Base, OH 45433-7750**

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**MATERIALS AND MANUFACTURING DIRECTORATE  
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<b>13. SUPPLEMENTARY NOTES</b> This report is a bibliography.					
<b>14. ABSTRACT (Maximum 200 Words)</b> The objectives of the Manufacturing Research WUD 54 are to 1) conduct in-house research to develop advanced materials process design/control technologies to enable more repeatable and affordable manufacturing capabilities and 2) to manage a contractual program to address the maturity of future enabling nano-manufacturing technology in terms of cost, performance, schedule, risk, qualification, and readiness.					
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## **Materials Process Design Branch – WUD 54**

### **For Period: 1990- 1997**

The objectives of the Manufacturing Research WUD54 are to 1) conduct in-house research to develop advanced materials process design / control technologies to enable more repeatable and affordable manufacturing capabilities, and 2) to manage a contractual program to address the maturity of future enabling nano-manufacturing technology in terms of: cost, performance, schedule, risk, qualification, and readiness.

In the near term, the in-house WUD research focus is on processing models and sensors:

- extending the in situ role of Raman spectroscopy and X-ray diffraction,
- real-time process optimization ( bulk and thin-film materials ),
- neural net based molecular dynamics (process modeling & design )

The mid to far-term focus is on virtual processing:

- virtual sensors ( using models in situ to extend the limits of sensed data )
- 3-D process imaging ( gradient materials process control )

In the near term, the contractual program focus is on manufacturing science initiatives:

- collaborative design-mfg trades environment,
- engine component fatigue data management ( for fleet readiness assessment ),
- nano-mfg technology readiness networks,

The mid to far-term focus is on virtual factories:

- virtual factory modeling and simulation
- nano-manufacturing technology repositories
- manufacturing technology-workforce partnerships

Attached is a list of all the technical reports, books, journal issues, journal articles, invited talks, refereed conference papers, non-refereed conference papers, thesis & dissertations, technical briefs and patents.

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Gunasekera, J.S., & Malas, J.C., **Conceptual Design of Control Strategy for Hot Rolling**, Annals of the CIRP, Vol. 40, No.1. 1991, pp. 123-126.

Pao, Y., & Sobajic, D., **Neural Networks and Knowledge Engineering**, Institute of Electronic and Electrical Engineers (IEEE) Transactions on Data and Knowledge, IEEE Press, New York, New York, Volume 1, Issue 1, 1991.

LeClair, S.R., **Self-Directed Process Control: Can we build material processing systems that know better how to process a material than we do?**, Concurrent Engineering Journal, Auerbach Publishers, New York, NY, Volume 1, Number 2, March 1991.

Chen, C.T., & LeClair, S.R., **A Probability Neural Network (PNN) Estimator For Improved Reliability of 'Noisy' Sensor Data**, Journal of Reinforced Plastics and Composites, Technomic Publishing Co., Lancaster, PA, Vol 10, Number 4, July 1991, pp. 379-390.

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Pao, Y. & Sobajic, D., **Nonlinear Process Control with Neural Nets**, Neurocomputing, North-Holland, Elsevier Science Publishers, Amsterdam, The Netherlands, Volume 2, Number 2, pp. 47-53, July, 1990.

## Invited Talks:

1997

Jackson, A.G., Laube, S.J.P., & LeClair, S.R., **Dynamics of Discovery in Materials Process Design**, Innovations in Materials Design Symposium, 5th Japan International SAMPE Symposium & Exhibition, Tokyo, Japan, 27 October 1997.

Malas, J.C., Frazier, W.G., & Medina, E. A., **New Design Tools for Material Processes**, U.S. Army Missile Command's Life Cycle Systems Workshop, Huntsville, Alabama, November 1997.

LeClair, S.R., **Electronic Prototyping: Toward Self-improving Atomic-scale Materials Design**, University of Wollongong, Wollongong, Australia, 21 July 1997.

Jackson, A.G., **Sensor Principles and Physical Properties**, Spring Workshop on Sensors and Process Control in Aluminum Metalcasting, Metal Processing Institute, Worcester Polytechnic Institute, Worcester, MA, 29 May 1997.

LeClair, S.R., **Electronic Prototyping: Towards Virtual Materials Research**, NEC Research, Princeton, New Jersey, 16 February 1997.

1996

Gunasekera, J.S., Fischer, C., Malas, J.C., Mullins, W.M., Yang, M., & Glassman, N., **The Development of Process Models for Use with Global Optimization of a Manufacturing System**, ASME Symposium on Modeling, Simulation and Control of Metal Processing, Atlanta, Georgia, November 1996.

J. C. Malas, **Opportunities for getting the Latest Materials Processing Technologies and Inventions Developed by the U. S. Air Force** Dayton Chapter of SME, Dayton, Ohio, September 1996.

J. C. Malas, **Future Directions in Computational Materials Science**, Institute for Computer Applications in Science and Engineering, NASA Langley Research Center, Hampton, Virginia, October 1996.

C. Fischer, J. S. Gunasekera & J. C. Malas, **Process Model Development for Optimization of Forged Disk Manufacturing Processes**, Proceedings of Second ASTM Symposium on Steel Forgings, New Orleans, Louisiana, November 1996.

Malas, J.C., **Microstructure-Driven Design**, AFOSR Workshop on Electronic Prototyping, Athens, Ohio, May 1996.

Malas, J.C., **Future Directions in Computational Materials Science**, Institute for Computer Applications in Science and Engineering, NASA Langley Research Center, Hampton, Virginia, October 1996.

LeClair, S.R., **Electronic Prototyping**, Tennessee Technological University, 112th International Conference on Computer-Aided Production Engineering, Cookeville, TN, August 1996.

LeClair, S.R., **Electronic Prototyping**, North Carolina State University, Industrial Engineering Seminar, Raleigh, NC, February 1996.

LeClair, S.R., **Materials Process Design Research**, University of Dayton, Seminar Series, Dayton, Ohio, January 1996.

1995

LeClair, S.R., **Materials & Process Information Highway**, National Materials Advisory Board, National Research Council, Washington, D.C., December 1995.

LeClair, S.R., **Innovations in Materials Design**, Special Session of Japan SAMPE Conference and Exposition, Tokyo, Japan, Sep, 1995.

Pao, Y.H., **Philosophy, Biology, Mathematics and Progress in Information Processing Technologies**, Second IFAC Symposium on Control of Power Plants and Power Systems, Cancun, Mexico, December, 1995.

Pao, Y.H., **Visual Associative Memory for Systems Monitoring**, Second IFAC Symposium on Control of Power Plants and Power Systems, Cancun, Mexico, December, 1995.

Pao, Y.H., **The 2D Visual Episodal Associative Memory**, (Plenary Talk) Artificial Neural Networks in Engineering (ANNIE) Conference, Rolla, MO, November, 1995.

Pao, Y.H. **Dimension Reduction, Feature Extraction and Interpretation of Data with Network Computing**, Ohio Aerospace Institute Neural Network Symposium and Workshop, Athens, OH, Aug, 1995.

LeClair, S.R., **Intelligent Processing: Toward Automated Materials Research**, Ohio Aerospace Institute Neural Network Symposium and Workshop, Athens, OH, Aug, 1995.

Adams, S.J., **MBE Data Collection using InfoScribe™**, International Conference on Monitoring and Control Techniques for Intelligent Epitaxy organized by Engineering Foundation Conferences, Banff Canada, June 1995.

## 1994

Malas, J.C., Ray, R., Yurek, T., & Chemaly, A., **Developments in Hot Extrusion Process Design and Control Methods**, 10th Annual World Tube Congress, Schaumburg, IL, Oct. 1994 (sponsored by American Tube Association).

Pao, Y.H., **A Computational Intelligence Approach to Intelligent Systems: Interrelationships between Neural-net Computing, Evolutionary Programming, Fuzzy Sets and Expert Systems** (Plenary Talk), Proceedings of International Conference on Intelligent System Application to Power Systems, pp. 537-540, Montpellier, France, September, 1994.

LeClair, S. R., **Intelligent Controllers**, 41st Sagamore Army Research Conference, Plymouth, MA, Aug, 1994.

Park, G.H. & Pao, Y.H., **System Identification and Noise Cancellation via Neural Net Computing**, Proceedings of the IEEE World Congress on Computational Intelligence, Orlando, FL, June 1994.

Pao, Y.H., **Neural Net Process Monitoring and Optimization for Power Systems**, Proceedings of the IEEE World Congress on Computational Intelligence, Orlando, FL, June 1994.

Malas, J.C., **Quality Engineering and Control of Material Processes**, Workshop on Advanced Materials Processing, Ohio University, Athens, OH, June 1994.

Malas, J.C., Frazier, W.G., Banda, S., Berg, J., **New Model-Based Control System Design Techniques: Forging of TiAl**, Intelligent Processing of Materials Conference, AEROMAT '94, Anaheim, CA, June 8, 1994 (sponsored by ASM Int'l).

Berg, J., Adams, R.J., Malas, J.C. and Banda, S.S., **Optimal Control of Metal Forging**, 1994 AFOSR Workshop on Optimization and Control, Blacksburg, VA, April 1994.

Malas, J.C., **Model-Based Control System Design Strategies**, International Workshop on The Application of Closed-Loop Control in Metal Forming Processes, Michigan Technological University, Houghton, MI, March 24, 1994 (sponsored by NSF).

Malas, J.C. & Irwin, R.D., **Quality Engineering and Controls**, Advanced Materials Processing Workshop, Ohio University, Athens, OH, June 16, 1994.

LeClair, S. R., **Future Directions in Design and Control of Materials Processing**, 6th Annual Life-Cycle Design Meeting, Columbus, OH, June 9, 1994.

LeClair, S. R., **Dual-Use, Technology Reinvestment, Advanced Technology Programs, etc.: Where Might We Go From Here?**, Keynote Address at 1994 Conference with Industry, Lehigh University, Bethlehem, PA, 24 May 94.

LeClair, S. R., **Qualitative Process Automation for Autoclave Curing of Polymer Composites**, United Technologies Engineering Coordination Activities Conference, Springfield, MA, 28 April 94.

Jackson, A. G., **Applications of Knowledge-Bases in Materials Science**, Industrial Liaison Program, 16th Annual Conference at the University of California, Berkeley Campus, Berkeley, CA, March 9, 1994.

Stark, E.F. & Laube, S.J.P., **Artificial Intelligence in Process Control of Pulsed Laser Deposition**, Abstract submitted to Symposium on Artificial Intelligence in Real-Time Control, Valencia, Spain, 5 Oct 94.

Laube, S.J.P., **Self-Directed Control of Pulsed Laser Deposition**, Advanced Materials and Processes Conference (AEROMAT '94) Anaheim CA, June 1994.

## 1993

LeClair, S. R., **Memory-Driven Design: Future Directions**, 1993 International Federation of Information Processing, Towards World Class Manufacturing Conference, Chair of the Design, CAD, & Feature-Based Methodologies Panel, September 13, 1993.

Garrett, P.H., **Architectures for Intelligent Process Control Systems**, Proceedings of 8th IEEE Symposium on Intelligent Control, Chicago, August 1993.

Rueggsegger, Steven M. **Intelligent Planning for Computer-controlled Inspection**, Proceedings of 1993 International Neural Network Society Annual Meeting, World Congress, Portland, OR, July 1993.

Cass, R., & Wilson, E., **Neural Network Systems for Modeling in Product Design**, Proceedings of International Neural Network Society, World Congress, Portland, OR, 11-13 July 93.

LeClair, S. R., **Memory-Driven Design: Process Design using an AND/OR Neural Net**, Proceedings of the International Neural Network Society, World Congress, Portland, OR, 11-13 July 93.

Laube, S.J.P., **Self-Directed Control of Pulsed Laser Deposition**, Advanced Materials and Processes Conference (AEROMAT '93) Anaheim CA, June 1993.

LeClair, S. R., **Memory-Driven Design: Inductive-Deductive Coupling**, Invited Speaker for MCAD 93, Symposium for Society of Industrial and Applied Mathematics, Ann Arbor, Michigan 25 May 1993, .

LeClair, S. R., **Memory-Driven Design: Optimization using a Genetic Algorithm**, Invited Speaker for Intelligent Systems - Concepts and Applications, Cleveland, Ohio, 20 May 1993.

LeClair, S. R., **Memory-Driven Design: Feature Sequencing**, Invited Speaker for Special Interest Group for Artificial Intelligence Technology, Dayton, Ohio, 8 Apr 1993.

Laube, S.J.P., **Feedback Control of Pulsed Laser Deposition Processes**, (presentation and poster session) Conference on Laser Ablation (COLA), Knoxville TN, April 1993.

Chen, C.L.P., **Intelligent Assembly Planning System**, Invited Speaker for Center for Artificial Intelligence Applications, Dayton, Ohio, 20 Feb., 1993.

Malas, J.C., **Advanced Control System Design Methods for Thermo-mechanical Processes**, Invited Lecture for Process Physics Laboratory of General Electric Corporate Research and Development, Schenectady, NY, 20 Oct 92.

Malas, J.C., **Using First Principles to Design Thermomechanical Processes**, Invited Speaker, ASM Forging Technology Conference, Pittsburgh, PA, June 30-July 1, 1992.

LeClair, S. R., **Real-Time Control: The Need for a Vocabulary and Memory**, 1992 International Federation of Automatic Control, International Symposium on Artificial Intelligence in Real-Time Control, Delft, the Netherlands, 18 June 1992, pp 421-431.

Pao, Y.H., **Using Neural-Net Computing to Formulate Real-Time Control Strategies**, 1992 International Federation of Automatic Control, International Symposium on Artificial Intelligence in Real-Time Control, Delft, the Netherlands, 18 June 1992, pp 339-346.

Laube, S.J.P., **Intelligent Control of Pulsed Laser Deposition**, 1992 Advanced Materials and Processes Conference (AEROMAT '92) Anaheim CA, 18-21-May 1992.

Malas, J.C., **Methodology for Design of Thermomechanical Processes**, Invited Speaker and Panelist for Special Workshop on Design at MIT, January 1992.

LeClair, S. R., **In Search of Speed . . . . the Rapid Design System - Memory Driven, Feature-Based Design**, 1991 Computer and Automated Systems Association (CASA) of the Society of Manufacturing Engineers (SME) 282 Seminar, Seattle, WA, 26 March 1991.

Malas, J.C., **Conceptual Design of Hot Rolling based on Design Axioms**, Invited Lecture for Laboratory for Manufacturing and Productivity, MIT, March 1991.



## Refereed Conference Papers:

1997

Jackson, A.G., Laube, S.L.P., & LeClair, S.R., **Dynamics of discovery in materials process design**, Proceedings of 5th Japan International SAMPE Symposium and Exhibition (JISSE-5), Oct 28-31, 1997, Toyko, Japan

Malas, J.C., Frazier, W.G., & Medina, E.A., **New Design Tools for Material Processes**, U.S. Army Missile Command's Life Cycle Systems Workshop, Huntsville, AL, 4-5 November, 1997.

Malas, J.C., Medina, E.A., Dubrosky, B., & Gegel, H., **Interactive Simulation System for Design of Multi-Stage Material Processes**, International CIRP Design Seminar, Los Angeles, CA, 8-10 October, 1997.

Igel'nik, B., Pao, Y.H., and LeClair, S. R., **Efficient representation of data density by a neural net**, Proceedings of The 5th European Congress on Intelligent and Soft Computing, Vol. 1, pp. 537-541, Aachen, Germany, September 8-12, 1997.

Jones, J.G., Jero, P.D., Kent, D.J., Busbee, J.D., & Liptak, D.C., **In situ Control of Interface Coatings on Fibers using CVD**, Proceedings of Symposium on Advances in Ceramics and Ceramic Composites, American Society of Mechanical Engineers 1997 Congress, Dallas, TX, 16 November 1997.

Wu, Y., Rong, Y., Ma, W. & LeClair, S.R., **Automated Modular Fixture Planning: Accuracy, Clamping and Accessibility Analysis**, Proceedings of American Society of Mechanical Engineers (ASME) Mechanical Engineering Congress and Exposition, Dallas, TX, 16-21 November 1997.

Malas, J.C., Venugopal, S., Frazier, W. G., Medina, E.A., Medeiros, S., Mullins, W.M., Deshpande, N.U., & Chaudhary, A., **Microstructure Driven Design for Hot Deformation Processes**, Proceedings of 1997 ASM/TMS Materials Week, Indianapolis, IN 14-18 Sep 1997.

Conrad, D., LeClair, S.R., & Oxley, M., **Data-Driven Process Discovery: Toward Automated Relational Signal Analysis**, Proceedings of the 5th European Congress on Intelligent Techniques and Soft Computing, Aachen, Germany, 8-12 Sept 1997.

Jackson, A.G., Benedict, M.D., & LeClair, S.R., **Cellular Automata based Models of Thin Film Growth**, Proceedings of Australasia-Pacific Forum on Intelligent Processing and Manufacturing of Materials, July 14-17, 1997, Gold Coast, Australia.

Gunasekera, J.S., Fischer, C., Malas, J.C., Mullins, W., & Yang, M. **Optimization of a Discrete Event Manufacturing Process**, Proceedings of Australasia-Pacific Forum on Intelligent Processing & Manufacturing of Materials, July 14-17, 1997, Gold Coast, Australia.

Jackson, A.G., Busbee, J.D., Liptak, D. Jones, J.G., & LeClair, S.R., **Raman Spectroscopy for Control of Thin Film Thickness and Material Properties**, Proceedings of 8th International Symposium on Nondestructive Characterization of Materials, Boulder, CO, 15-20 Jun 97.

Chen, C.L.P., Cao, Y., & LeClair, S.R., **Orthogonal functional basis neural network for functional approximation**, Proceedings of IEEE International Conference on Neural Networks, Houston, TX, June 8-12, 1997, pp. 204-209.

Jones, J.G., P.D. Jero, & D.J. Kent, **Process Control of Chemical Vapor Deposition of Fiber Coatings**, Proceedings of Annual Meeting of Ceramics Society, Cincinnati, OH, May 6, 1997,

Rueggsegger, S. & Freudenberg, J., **Improved Fluorine Actinometry in a CF<sub>4</sub>/Ar Plasma by Estimating Argon Dilution**, Proceedings of 191st Electrochemical Society Meeting, Montreal, Quebec, Canada, May 4, 1997

Adams, S.J., Eyink, K.G., Haas, T.W., **Improved Knudsen Cell Thermal Control using Optical Fiber Thermometry**, Proceedings of Monitoring and Control Techniques for Intelligent Epitaxy II, Kananaskis, Alberta, Canada, 6-10 April 1997.

Gustafson, S.C., Little, G.R., & LeClair, S.R., **Laser Beam Shaping Using Deformable Mirrors**, Proceedings of International Conference on Rapid Prototyping, San Francisco, CA, 3 Apr 1997.

Igel'nik, B., Pao, Y.H., and LeClair, S. R., **Estimating data grouping by a neural net**, Proceedings of the 31st Annual Conference on Information Sciences and Systems, Vol. 2, pp. 540-545, The Johns Hopkins University, Baltimore, MD, March 19-21 1997.

Biggers, R.R., Murray, P.T., Mast, D., Maartense, I., Peterson, T.L., Dempsey, D., Varanasi, C., Murray, S., Lubbers, D., Laube, S., Lovett, B., Moser, E.K., Brown, J.L., Liptak, D.C., and Busbee, J., **Spectral-Component Monitoring and Control of Pulsed Laser Deposition of YBCO Films**, The 1997 International Society for Optical Engineering (SPIE) Proceedings, Febuary 1997, San Jose, CA

LeClair, S.R., Jackson, A. G., Benedict, M.D., Conrad, D.M., and Cao, Y., **Electronic prototyping: toward future applications of sensors in materials processing**, Proceedings of TMS Symposium on Advanced Sensors in Materials Processing, Orlando, FL, February, 1997.

Jackson, A. G., Laube, S. J. P., and Jones, J. , **Spectroscopic methods for control of thin film growth**, Proceedings of TMS Symposium on Advanced Sensors in Materials Processing, Orlando, FL, February, 1997.

Busbee, J.D., Lubbers, D.P., Jackson, A.G., Biggers, R.R., Liptak, D.C., and Maartense, I., **Raman spectroscopy for determining YBCO thin film paramters in situ**, Proceedings of TMS Symposium on Advanced Sensors in Materials Processing, Orlando, FL, February, 1997.

Jia, Z., Gunasekera, J.S., & Malas, J.C., **Application of Upper Bound Element Technique (UBET) to the Forging Process**, Proceedings of International Conference on Computational Engineering Science, ICES '97 Conference, Costa Rica, May 1997.

## 1996

Gunasekera, J.S., Fischer, C. & Malas, J.C., **Process Model Development for Optimization of Forged Disk Manufacturing Processes**, Second ASTM Symposium on Steel Forgings, New Orleans, Louisiana (Nov 96).

Gunasekera, J.S., Fischer, C., Malas, J.C., Mullins, W.M., Yang M. & Glassman, N., **The Development of Process Models for Use with Global Optimization of a Manufacturing System**, ASME Symposium on Modeling, Simulation and Control of Metal Processing, Atlanta, Georgia, November 1996.

Jackson, A.G., **Finding Compound Property Patterns in Empirical Data Sets using Discovery Methods**, International Union of Crystallography XVII Congress and General Assembly, Seattle, WA, August 1996.

Brown, F. M., Peterson, N., Jacobs, G., Jackson, A.G., & LeClair, S.R., **A Description and Analysis of Gladun's Pyramidal Net Classification Theory**, Proceedings of the Adaptive Distributed Parallel Computing Symposium, Dayton, OH, 8-9 August 1996.

Pao, Y.H., Shen, C.Y., & Meng Z., **Optimization with Dimension Reduction Through Learning of Nonlinear Variance-Constrained Mapping**, Proceedings of the Adaptive Distributed Parallel Computing Symposium, Dayton, OH, 8-9 August 1996.

Fairchild, S., **Protein Secondary Structures Prediction using a Mahalanobis Distance Classifier and a Probabilistic Neural Network**, Proceedings of the Adaptive Distributed Parallel Computing Symposium, Dayton, OH, 8-9 August 1996.

Ye, S. & Chen, C.L.P., **Periodic Time Series Analysis using Neural Networks**, Proceedings of the Adaptive Distributed Parallel Computing Symposium, Dayton, OH, 8-9 August 1996.

Malas, J.C., Chaudhary, A.B., Mullins, W.M., Medina, E.M., Venugopal, S., Medeiros, S., Irwin, R.D., Frazier, W.G., and Srinivasan, R., **Optimization of Microstructure Development: Application to Hot Metal Extrusion**, ASME Engineering Systems Design and Analysis Conference, Montpellier, France, Vol. 3 (ASME PD-Vol. 75), July 1996.

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